# Hot-Plug RAID Memory technology

technology profile

## Introduction

As a leader in the advancement of industry-standard technology, HP developed Hot Plug RAID Memory to give enterprise-class servers the level of memory fault tolerance today's 24x7 applications demand. Hot Plug RAID Memory provides redundancy and hot-plug capabilities for industry-standard dual inline memory modules (DIMMs), to deliver unprecedented levels of availability, scalability, and fault tolerance.

## Detection and correction

Because memory is an electronic storage device, it has the potential to return information different from what was originally stored. The only true protection from memory errors is to use some form of memory detection or correction protocol.

Error checking and correcting (ECC) memory is now standard in all ProLiant servers and significantly reduces the probability of fatal memory errors. The ECC commonly used in industry-standard servers can detect both single-bit and multibit errors, and it will actually correct single-bit errors.

However, research has shown that the number of soft errors increases as memory capacity increases. Since some percentage of these soft errors will be multibit errors that ECC cannot correct, the potential for failure in ECC systems also increases as memory capacity increases (Figure 1). With each new generation of servers, memory capacity increases, and so does the potential for system failures.

Hot Plug RAID Memory provides a level of protection far greater than standard ECC-based solutions and allows the detection of otherwise undetectable errors (Table 1).

**Figure 1.** Server outages during a one-year period due to memory failures in systems with ECC memory
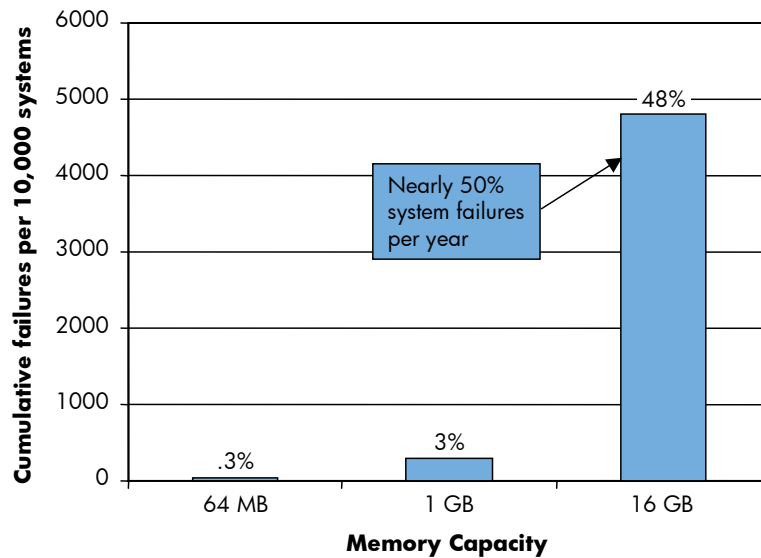


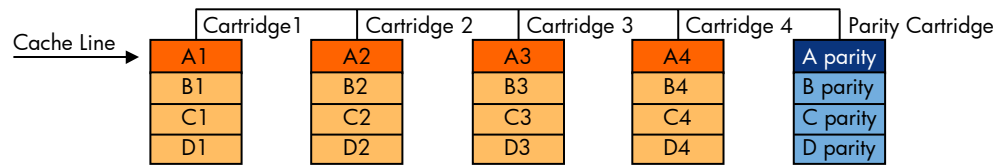**Table 1:** Comparison of protection provided by parity checking, ECC, and Hot Plug RAID Memory

| Error Condition | Parity | Standard ECC | RAID Memory |
|---|---|---|---|
| Single-bit | Detect | Correct | Correct |
| Double-bit | Unreliable | Detect | Correct |
| 4-bit DRAM | Unreliable | Detect | Correct |
| 8-bit DRAM | Unreliable | Unreliable | Correct |
| Greater than DRAM | Unreliable | Unreliable | Detect |

## Hot Plug RAID Memory

For years, the computer industry has used redundant array of independent disk (RAID) technology to provide fault tolerance and high availability for disk drive subsystems in servers. The technology used in Hot Plug RAID Memory is conceptually similar to RAID storage technology. However, in the context of the memory solution, RAID stands for redundant array of industry-standard DIMMs.

ProLiant servers with Hot Plug RAID Memory technology use five memory controllers to control five cartridges of industry-standard synchronous dynamic random access memory (SDRAM). When a memory controller needs to write data to memory, it splits a cache line of data into four blocks (shown as A, B, C, and D in Figure 2). Then each block is written, or striped, across four of the memory cartridges. RAID logic calculates parity information, which is stored on the fifth cartridge. With the four data cartridges and the parity cartridge, the data subsystem is redundant such that if the data from any DIMM is incorrect or if any cartridge is removed, the data can be recreated from the remaining four cartridges.

**Figure 2.** Data striping in Hot Plug RAID Memory.

| Cache Line | Cartridge1 | Cartridge 2 | Cartridge 3 | Cartridge 4 | Parity Cartridge |
|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | A parity |
| | B1 | B2 | B3 | B4 | B parity |
| | C1 | C2 | C3 | C4 | C parity |
| | D1 | D2 | D3 | D4 | D parity |

# Additional capabilities

The redundancy in Hot Plug RAID Memory provides the ability to hot plug memory cartridges without bringing down the server. This gives unprecedented levels of memory availability and scalability within industry-standard servers. Hot Plug RAID Memory enables hot replacing a failed DIMM, hot adding a DIMM to a memory cartridge, and hot upgrading a set of DIMMs with a different (higher capacity) set.

In addition to hot-plug memory capabilities, HP Hot Plug RAID Memory enables several ease-of-use features. HP Hot Plug RAID Memory inherently supports features such as control of LEDs, locks, and alarms to indicate good or bad DIMMs for visible and audible control of the hot-plug RAID memory process. Additional levels of ease of use can be facilitated through software for advanced diagnostics and health indications, making managing Hot Plug RAID Memory easy and reliable.

## Call to action

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